Systems Engineering e-Portfolio

Patricia A. DeMent-Myers

Portland State University
Systems Engineering: Masters Program
Program Director and Advisor: Dr. Herm Migliore
SYSE 590 Integrative Workshop-Student e-Portfolio
Table of Contents

Table of Contents ....................................................................................................................................... 2

1. Introduction ......................................................................................................................................... 3

2. Learning Objectives / Goals .................................................................................................................. 3

3. Coursework Outline .............................................................................................................................. 4

3.1. SYSE 573: Requirements Engineering .......................................................................................... 4

3.2. SYSE 590: Integrative Workshop ................................................................................................... 5

3.3. SYSE 591: Systems Engineering Approach ................................................................................... 6

3.4. EMGT 540: Operations Research in Engineering Management .................................................. 6

3.5. SYSE 561: Logistics Engineering .................................................................................................. 7

3.6. EAS 561: Reliability Engineering .................................................................................................. 7

3.7. SYSC 529: Business Process Modeling & Simulation .................................................................. 8

3.8. SYSE 575: Reducing Risk in Decision Making ............................................................................. 8

3.9. SYSE 595 Hardware-Software Integration .................................................................................... 9

3.10. SYSE 506: Masters Project ........................................................................................................... 10

4. Program Evaluation ............................................................................................................................. 10

5. Revision History ................................................................................................................................ 11

6. References/Works Cited ....................................................................................................................... 11
1. Introduction

Systems engineering is a methodology and framework for managing technological complexity. The application of systems engineering revolves around three core principles: systems management, requirements/architecture definition, as well as systems integration and verification. Systems engineering focuses on the system as a whole by holistically emphasizing its total operation. It assumes a non-reductionist engineering perspective by looking at a system from the outside through its interactions with other systems and the environment. Such approach demands not only the engineering design of the system, but also the external factors that govern and constrain the design. Systems engineering also adopts a management perspective in order to control the total system development effort for the purpose of achieving an optimum balance of all system elements. It is a process of transforming an operational need into a description of systems parameters and integrates such parameters to optimize the overall system effectiveness.

2. Learning Objectives / Goals

My primary objective in pursuing this program was to not only improve my skills in my current position as a automation systems engineer but to grow my skill set to possible pursue another career path in the future. At the time my employer had pending layoffs and redeployments, and were supporting employee efforts to improve their skills and marketability. Fortunately I found a new position internally and continued my pursuit of the Systems Engineering Masters program.

During the course of this program I changed positions with my employer several times. I moved from an automation systems engineer, to a failure analysis lab supervisor, to an operations manager of a mother board development group, and currently to a systems program manager implementing new software systems. Although the scope of different positions varied considerably, the relevance of the systems engineering program carried through to all the various positions and I was able to apply concepts and learning throughout.

My original strategy when I started the program was to tailor my program as closely as possible to my then current job role, focusing the coursework to automated material handling systems and modeling. As I progressed in the program I determined that an alternative strategy is to focus on diversifying the coursework to gain a broader knowledge base. At the start and end of the program, I leaned towards the pursuit of a more diverse track of coursework.
3. Coursework Outline

<table>
<thead>
<tr>
<th>Year</th>
<th>Term</th>
<th>Course</th>
<th>Course Title</th>
<th>CREDIT TYPE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Core</td>
<td>Required</td>
</tr>
<tr>
<td>2009</td>
<td>Spring</td>
<td>SYSE 573</td>
<td>Requirements Engineering- McKinney/Carswell</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>SYSE 590</td>
<td>Integrative Workshop- Migliore</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall</td>
<td>SYSE 591</td>
<td>Systems Engineering Approach- Eisenhauer</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>EMGT 540</td>
<td>Operations Research in Engineering &amp; Technology Management- Anderson-complete in winter 2011</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>SYSE 561</td>
<td>Logistics Engineering- Carswell</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>EAS 561</td>
<td>Reliability Engineering- Eisenhauer</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall</td>
<td>SYSC 529</td>
<td>Business Process Modeling &amp; Simulation- Wakeland-Complete in Spring 2012</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>SYSE 575</td>
<td>Reducing Risk in Decision Making-Eisenhauer</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>SYSE595</td>
<td>Hardware-Software Integration-Blyer</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Spring</td>
<td>SYSE 506</td>
<td>Masters Project-Migliore</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Credits Required: 16 13 16 45
Credits Completed: 16 13 16 45

Courses in BOLD are complete | Courses in Italics are in process | Courses in GREY are pending

3.1. SYSE 573: Requirements Engineering

Course Description:

This course provides the knowledge and skills necessary to translate needs and priorities into system requirements, and develop derived requirements, which together form the starting point for engineering of complex hardware/software systems. The student will develop an understanding of the larger context in which requirements for a system are developed, and learn about trade-offs between developing mission needs or market opportunities first versus assessing available technology first. Techniques for translating needs and priorities into an operational concept and then into specific functional and performance requirements will be presented. The student will assess and improve the usefulness of requirements, including such aspects as correctness, completeness, consistency, measurability, testability, and clarity of documentation. Case studies, many involving software-intensive systems, will be used.

Reflection: [Term: Spring 09]

This course was my first systems engineering course and proved to be an excellent introduction to the program. Although I had a small amount of exposure to requirements development with previous work, I had not had any formal requirements training. The information and knowledge gained was immediately applicable in my current project management roles. The material in the course proved to be very relevant I was able to put this information to immediate use. Another view point around requirements for me was the marketing and technology trade-offs and assessing needs from an external customer perspective.
Amendment (after 5th course): After progressing through the program I noted that I may have gained more from this course had I taken it later in the program. Although, it was not specifically a problem and I understood the material well, I think that I have gained other insights from other courses which would have been a benefit for this requirements course. Alternatively there was a trade off given that I gained insights from this class which provided benefit for some of the other courses taken later in the program.

SYSE 573 Final Project:

3.1. SYSE 590: Integrative Workshop

Course Description:

Systems engineering is an acquired behavior to be developed throughout the Masters degree program. Students and faculty advisors will engage in creative workshop activities integrating technical specialty skills and project experience invoking systems engineering applications of communication, synthesis and creativity, team building, problem solving, management of time and resources, and system life-cycle thinking. A student portfolio will document the program plan and document that the desired behavioral change is taking place.

Reflection: [Term: Summer 2009]

I used the opportunity in the course to evaluate my background and experience and analyze what coursework track would give me the most benefit. My background as a systems engineer of an automated material handling system in a high volume manufacturing facility is closely tied to a variety of courses across several of the system’s engineering tracks. After studying the syllabus of several of the courses I struggled with making a decision to either choose a track which is closely tied to my current work, or to diverge into other tracks for a broader learning experience.

For example one aspect of my day to day role is to perform system modeling on an automated material handling system for product delivery. On one hand there is a benefit to further developing skills with the manufacturing systems simulation course (SYSC 553). The course description outlines material which is closely aligned with my current systems engineering role. This course would not only integrate nicely with my job role but could provide an excellent source for knowledge sharing within the course.
3.2. **SYSE 591: Systems Engineering Approach**

**Course Description:**
Engineering of complex hardware, software systems encompasses quantitative methods to understand vague problem statements, determine what a proposed product/system must do (functionality), generate measurable requirements, decide how to select the most appropriate solution design, integrate the hardware and software subsystems and test the finished product to verify it satisfies the documented requirements. Additional topics that span the entire product life cycle include interface management and control, risk management, tailing of process to meet organizational and project environments, configuration management, test strategies and trade-off studies.

**Reflection:** [Term: Fall 09]
This course provided an excellent foundation and understanding to systems engineering (SE) and how SE concepts are applied within different industries. I am writing this reflection after taking two other SE courses and have found that the material covered in this course became more relevant as I progressed through the program. I frequently found myself referencing this course’s material and text. The content in this course formalized concepts and created a SE structure to apply in everyday use.

3.3. **EMGT 540: Operations Research in Engineering Management**

**Course Description:**
Resource optimization is studied through mathematical programming. Emphasis is placed on applying linear programming, and goal programming to engineering management decisions. Problem formulation, mathematical model building, basic principles behind the Simplex algorithm, and multiple objective linear optimization via goal programming are included in the course. Post-optimality analysis is studied from the viewpoint of technology management. The course includes a term project involving a real-life problem.

**Reflection:** [Term: Winter 2011]
This course proved to be one of the more challenging courses in the program, but also one of the most relevant and interesting. I was able to use a current work problem for our team project but that project alone proved to very time consuming. Although the project was an excellent platform to cement the modeling concepts, balancing the workload between the project and homework, and workload was extremely challenging. Instructor had excellent knowledge of the material and was very helpful whenever needed. The course material provides a very useful foundation for modeling. My caution on this course; be prepared for a heavy workload and don’t fall behind, extremely difficult to catch up. Also, don’t let the project time commitment overshadow the homework needs.
3.4. SYSE 561: Logistics Engineering

Course Description:
Concentrates on logistics from a systems engineering perspective. Systems will include a mix of products and processes, materials, equipment, software, people, data, information, and services, within some form of hierarchy. The design for supportability/serviceability, the production and effective distribution for customer use, and the sustaining maintenance will be addressed on a total system life-cycle basis, with particular emphasis in the early phases of the development of new systems and/or reengineering of existing systems. Prerequisite: basic knowledge of systems engineering concepts and statistics.

Reflection: [Term: Spring 10]
This was another class in the program which had relevance for me based on my current work environment. I found the material had a few technical differences in terminology but for the most part it was parallel to my experience with system engineering and systems performance metrics. Although I was familiar with some of the material, this course formalized concepts and provided a bigger picture while educating me on several new performance indicators and metrics. This course also provided good learnings about setting up a full systems indicator performance package and how to quantify important key metrics. This was the first offering for this course so there a few logistic type issues with blackboard and course expectations which I would expect to be resolve in future offerings as the course evolves.

No final project required for this course.

3.5. EAS 561: Reliability Engineering

Course Description:
Failure is a fact of engineering. No product or system can be assumed to work correctly 100% of the time. The engineering effort to even attempt to design such a system would be both time and cost prohibitive. In light of that, the reliability of systems cannot be ignored and must be studied to ensure, at least, we grasp the reality we are dealing with. This course provides an in depth study of the engineering and management of the reliability space. Including describing and quantifying reliability, as well as examining the modeling, test design, trade off analysis required of engineers involved with products and systems that do not perform 100% correct at all times.
Reflection: [Term: Summer 2010]

Reliability engineering course was a relevant course to my current work with regard to equipment performance reliability, performance metrics and general operations efficiencies. Equipment used in my organization at the time of this writing was dated, obsolete and without any maintenance support. Characterization of equipment performance was an essential part of establishing true baseline capability and a good maintenance program.

Our team project was based on a real life scenario of a team member who was tasked with evaluating the affects of a paint type on paint pump performance. The project was a good example in that the evaluation did not only focus on equipment but the affects of performance based on material differences and selection. The project outlines a methodology for evaluating material selection.

EAS 561 Final Project:

3.6. SYSC 529: Business Process Modeling & Simulation

Course Description:

The primary emphasis is on using discrete (and possibly continuous) system simulation models to analyze business processes, including administrative processes, decision-making, product development, manufacturing, and service delivery, etc. Discrete system models characterize the system as a flow of entities that enter and move through various processes, queues, and decision logic according to various probability functions specified by the modeler. Monte Carlo sampling is used to calculate statistical measures of system performance, such as throughput, average queue length, resource utilization, etc.

Reflection: [Term: Started Fall 2010, completed Spring 2012]

This course covered several methods for evaluating processes and entity models for decision making. Short projects using different methodologies were given to reinforce concepts.

SYSC 529 Final Project: Pending

3.7. SYSE 575: Reducing Risk in Decision Making

Course Description:

This course will examine the concepts, techniques and tools for managing risk and making decision as key components of the systems engineering process. In this course, risk connotes a measure of
the probability and severity of an undesired event. This course begins with an overview of the risk management (identifying, assessing, monitoring, and mitigating) and decision process. Differences between mission critical and non-mission critical programmatic risk will be emphasized. Other topics include the limits of expected value-based risk analysis, decision making strategies such as a max/min, min/max and regrets. Formal methods in risk analysis, elementary decision analysis and decision trees, multi-objective decision making, pareto techniques, optimality, and trade-off analysis will be covered. Risk and decision techniques will be contrasted with the interfacing processes of program management and software engineering, from both the government (DOD) and industrial perspectives.

**Reflection:** [Term: Spring 2011]

This course was focused on different types of risk analysis methods and their respective advantages / disadvantages, including different types of tools to perform analysis. My project was focused on analysis of a current work project and assessing the risk related to implement a new software application in a current environment. The project was of importance to my work because of a constrained budget and limited support organization. I used my project to perform a trade-off, risk and gap analysis before pursuing the project.

Final Project SYSE 575:

![SYSE575_ProjectFinal_dementmyers.pdf]( SYSE575_ProjectFinal_dementmyers.pdf )

### 3.8. SYSE 595 Hardware-Software Integration²

**Course Description:**

Systems Engineering is applied to the integration of hardware-software systems, focusing on embedded computer products development and information technology systems. Factors that affect the selection of hardware and software solutions in design will be examined, as well as the use of trade studies to optimize the efficiency of integration issues. Techniques for partitioning of system-level functions and requirements to hardware/software components will be provided, as will practical guidance, through case studies, process templates and design check-lists. Prerequisite: Basic understanding of hardware and software development.

**Reflection:** [Term: Summer 2011]

This course was under revision and class members were asked to use the standard material and make course improvement suggestions. The term was focused on learning some key terminology and concepts related to HW and SW integration, a mid-term and a modest project was required.
Additionally, SysML was touched on and discussed. I do not have a lot of feedback on the specifics of this course as it was under revision.

3.9.  SYSE 506: Masters Project

Course Description:

The nine credits of SYSE 506 are a capstone experience that exercises systems engineering concepts in a comprehensive project of interest to student and advisors. The student may work on a project potentially in their area of domain knowledge and potentially for their current employer, but the project must encompass: a) systems thinking, b) a systematic approach, c) identification of customer and stakeholder needs, d) requirements management, d) validation and verification, e) formal interface management f) assessment of results. The scope of the project is well defined and must satisfy objectives related to technical engineering, student learning, and systems engineering areas. The project generally starts with a formal proposal, continues with progress reports, and ends with a stand-alone final report.

SYSE 506 Final Project: Pending

4.  Program Evaluation

As mentioned previously in the introduction, this program spanned several position changes with my current employer. When I started the program my role was an automation systems engineer, responsible for an automated material system in high volume semiconductor factory. Almost every aspect of the program pertained directly to my work and I was able to apply key learnings right away and also draw from my specific work and apply it to my program’s coursework. I used the factory automated material handling system for my case study in the requirements course, focusing on the aspects related to implementation of a new software / hardware (SW/HW) system for factory automation.

The program’s ability to broaden my knowledge and skills in the systems engineering field far exceeded my expectations with regard to the relevance of the program and coursework to the various scopes from the different roles and positions. The flexibility of the program and ability to tailor the program to fit personal interests was of great benefit. Additionally, diverse knowledge and background of the instructors was an advantage. Each instructor, coming from different career fields brought very different perspectives in terms of application of the materials which I felt this enhanced the learning.
5. Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev 6</td>
<td>5/26/2012</td>
<td>Updated coursework, reflections for classes completed, final projects attached.</td>
</tr>
<tr>
<td>Rev 5</td>
<td>4/2/2012</td>
<td>Updated coursework, reflections for classes.</td>
</tr>
<tr>
<td>Rev 4</td>
<td>6/14/2011</td>
<td>Updated coursework completion for spring term 2011</td>
</tr>
<tr>
<td>Rev 3</td>
<td>4/17/2011</td>
<td>Revised curriculum slightly and added to section learning objectives.</td>
</tr>
<tr>
<td>Rev 2</td>
<td>1/4/2011</td>
<td>Modified curriculum for terms winter, spring summer 2011, moved final project to end of program.</td>
</tr>
<tr>
<td>Rev 1</td>
<td>6/21/2010</td>
<td>Updated SYSE 591, SYSE 561, SYSE 595 to Coursework outline-added reflections to last two terms.</td>
</tr>
<tr>
<td>Rev 0</td>
<td>8/28/2009</td>
<td>Initial portfolio submission after completion of SYSE 573 Requirements Engineering-Spring 09</td>
</tr>
</tbody>
</table>

6. References/Works Cited


[2] Course descriptions and program summary obtained from PSU Systems Engineering Website: [http://www.eas.pdx.edu/systems/courses/describe.php](http://www.eas.pdx.edu/systems/courses/describe.php)
